# Dairy Directions — Analysing Farm Systems for the Future

*Providing robust analysis of the impact of on-farm changes and innovation on the profitability of dairy farm systems*

# Sub-surface drip irrigation for lucerne production — does it pay?

## Why sub-surface drip irrigation?

Declining irrigation water availability has put significant pressure on dairy farmers to use water more efficiently. This has led to increased interest in:

- Alternative irrigation methods to flood irrigation, such as the micro-irrigation technology sub-surface drip irrigation (SSD), and
- Alternative forage systems to perennial ryegrass, such as lucerne.

A SSD irrigation system uses 'drip tape' fitted with 'emitters' that is installed below the soil surface. This tape releases water at a constant flow rate under pressurised conditions, delivering water directly to the plant root zone. Sub-surface drip irrigation can reduce evaporation losses, and also has the potential to deliver significant labour savings.

## Is SSD irrigation technology a worthwhile investment?

The answer is it depends. It will depend on the amount and value of additional fodder conserved and the amount and value of irrigation water saved. It will also depend on the capital cost of the SSD technology.

Using a partial budget analysis (over a 10 year period), a case study farm in the Goulburn Irrigation Region was used to investigate whether converting from flood irrigation to SSD irrigation to grow lucerne for hay/silage was a good investment.

Before changing, the case study farm was irrigated using a flood irrigation system, where 9 ML/ha irrigation water applied produced 15 t DM/ha of lucerne. Approximately 25 hectares was difficult to irrigate because of small and irregular shaped bays. This area had loam-type soil which required re-levelling or development in other ways to improve efficiency. The economics of installing SSD irrigation on this 25 ha was analysed. The capital cost associated with installing SSD in the first instance was estimated to be about $9,060/ha.

The high capital cost associated with installing SSD irrigation would require significant ongoing savings or benefits for it to be a worthwhile investment. The investment was considered to be worthwhile if the internal rate of return (IRR) was 10% or greater over a 10 year period (the expected life of the tape system). This level of IRR reflects the return only from the extra investment i.e. the SSD technology, not the return from the whole farm business. An IRR of 10% or more was chosen as SSD is still a comparatively high risk investment at present, and alternative investments are available. The risk is due to a) the longevity of the system not having been widely tested in the conditions of the following scenarios and b) individual management skills may not be capable of fully achieving the expected benefits. Therefore, in a project such as this, an IRR of 10% (or higher) is reasonable.

The IRR reported here is presented in 'real' terms, and therefore does not take into account inflation over time. It has also been calculated on cash flows before tax. To compare the IRRs presented here with alternative investments, e.g. bank interest rates, the inflation rate should be added to the IRRs. In doing so, the IRR for the installation of SSD to be considered a good investment should also be increased. For example, a nominal IRR of

## Key points

- Dairy farmers in irrigation regions are looking to grow lucerne using 'sub-surface drip' irrigation to make better use of limited water.
- However, sub-surface drip irrigation is costly. A combination of benefits from additional lucerne yield and water savings is required to justify converting from flood irrigation to sub-surface drip.

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15% could be used to indicate a profitable investment, if inflation and tax had been accounted for.

For the purpose of this analysis, the economic performance of a SSD system was compared to a flood irrigated system. It was assumed a SSD system could produce an additional 0, 3 or 6 t DM/ha more lucerne than a flood irrigated system, and this additional fodder had a value of $200, $300 or $400/t DM. Water savings of 0, 1.0, 2.3 or 3.9 ML/ha, valued at $150, $250 or $350/ML were also tested. Finally, capital set up costs of $9,060 and $6,560 were compared.

## How does it look if I increase my lucerne conservation?

Substantial increases in lucerne conservation were needed to justify the investment in SSD (Table 1). If additional lucerne was the only benefit, lucerne conservation needed to increase by 6 t DM/ha, compared to the yields achieved using flood irrigation, and this lucerne would need to be worth more than $300/t DM, each year for 10 years, to justify the investment.

Consistently conserving an additional 6 t DM/ha (worth more than $300/t DM) using SSD irrigation, compared to flood irrigation, each year for 10 years, has low probability. It is also questionable whether irrigated dairy farms would be profitable under such high fodder cost conditions and with average manufacturing milk prices.

**Table 1. Impact of additional lucerne conserved and value of lucerne on years for cash flow to break even and internal rate of return (%).**

| Extra lucerne (t DM/ha) | 3 | 3 | 6 | 6 |
|---|---|---|---|---|
| Value of extra lucerne ($/t DM) | 300 | 400 | 300 | 400 |
| Years to break even (before interest) | > 10 | >10 | 9 | 6 |
| Internal Rate of Return (IRR) | -8.5% | -1.3% | 5.0% | 17.2% |

## What if it means I use less irrigation water?

Water savings of 30% (3.9 ML/ha), valued at $350/ML were sufficient to justify investment in SSD irrigation (Table 2) i.e. earn 10% or more IRR. However, water savings of 3.9 ML/ha may not be possible in many on-farm situations without compromising yield. If water savings were the only benefit of SSD, the technology is unlikely to be an attractive investment.

Water savings of 3.9 ML/ha could be achieved if the SSD system was replacing a very inefficient flood irrigation system. However, water losses in such a system may also be reduced through the installation of a recycle dam or automation technology, which has a lower capital cost than the installation of SSD irrigation. In practice, water savings in the order of 10 to 20% are more likely with SSD technology.

**Table 2. Impact of water savings and water price on years for cash flow to break even and internal rate of return (%).**

| Water saved (%) | 10 | 20 | 30 | 30 |
|---|---|---|---|---|
| Water saved (ML/ha/yr) | 1.0 | 2.3 | 3.9 | 3.9 |
| Water price ($/ML) | 350 | 350 | 250 | 350 |
| Years to break even (before interest) | > 10 | >10 | 9 | 7 |
| Internal Rate of Return (IRR) | -10.2% | 0.4% | 4.2% | 12.1% |

## What if I get more lucerne from less water?

If an additional 3 t DM/ha lucerne was conserved, along with a 20% water saving (2.3 ML/ha), the additional feed would need to be valued at $400/t DM to earn a return of 10% or more on the investment (Table 3). In contrast, if 6 t DM/ha additional lucerne was conserved, with 20% water savings, a feed price of $300/t DM would generate an IRR of 16%.

**Table 3. Impact of different amounts of additional lucerne conserved and different amounts of water saved on years for cash flow to break even and internal rate of return (%).**

| Extra lucerne (t DM/ha) | 3 | 3 | 3 | 6 | 6 |
|---|---|---|---|---|---|
| Value of extra lucerne ($/t DM) | 200 | 400 | 400 | 200 | 300 |
| Water saved (%) | 30 | 20 | 10 | 30 | 20 |
| Water saved (ML/ha/yr) | 3.9 | 2.3 | 1.0 | 3.9 | 2.3 |
| Water price ($/ML) | 250 | 250 | 350 | 150 | 250 |
| Years to break even (before interest) | 8 | 7 | 8 | 9 | 6 |
| Internal Rate of Return (IRR) | 6.5% | 10.5% | 6.2% | 4.6% | 16.4% |

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## What if the capital cost decreased?

The capital costs associated with the installation of a SSD irrigation system can vary quite markedly depending on the type of tape, tape spacing, type of emitters and emitter spacings. Other factors such as distance from an appropriate electricity source can also influence installation costs. Grants, incentives or subsidies for installing SSD may be available and could potentially reduce these capital costs. To account for this situation, the capital cost of installing SSD was decreased by $2,500/ha, reducing capital costs from $9,060/ha to $6,560/ha.

As expected, a decrease in the capital cost leads to a higher return for the investment across a range of production gains and water savings (Table 4). An IRR of greater than 10% could be achieved by a 20% increase in lucerne conservation (3 t DM/ha, valued at $400/t DM) and water savings of 10% (1 ML/ha, valued at $250/ML).

In comparison to infrastructure improvements for flood irrigation, a capital cost of $6,560/ha is at the higher end of estimated costs associated with laser grading and installation of an automatic flood irrigation system for a lucerne stand. An automated flood irrigation system is less likely to generate significant water savings or increases in lucerne conservation compared to SSD irrigation, however, similar labour savings could be expected.

**Table 4. Impact of decreased capital cost (to $6,560/ha) on years for cash flow to break even and internal rate of return (%).**

| Extra lucerne (t DM/ha) | 3 | 3 | 3 | 6 | 6 |
|---|---|---|---|---|---|
| Value of extra lucerne ($/t DM) | 200 | 300 | 400 | 200 | 300 |
| Water saved (%) | 20 | 20 | 10 | 20 | 10 |
| Water saved (ML/ha/yr) | 2.3 | 2.3 | 1.0 | 2.3 | 1.0 |
| Water price ($/ML) | 250 | 250 | 250 | 250 | 250 |
| Capital cost ($/ha) | $6,560 | $6,560 | $6,560 | $6,560 | $6,560 |
| Years to break even (before interest) | 9 | 7 | 7 | 7 | 2 |
| Internal Rate of Return (IRR) | 3.3% | 11.8% | 11.4% | 11.5% | 19.5% |

## In summary

At present, SSD irrigation technology for lucerne conservation has high initial capital cost, some uncertainty regarding the durability of the system, and risks about whether sufficient additional lucerne using less water could be conserved to justify the investment.

This analysis suggests that if a combination of high additional lucerne production and water savings can be obtained, relative to the existing irrigation system, or the capital cost of SSD is reduced, the installation of SSD irrigation could be a worthwhile investment in some cases.

High water and fodder prices can make investing in SSD appear more attractive, but dairying may not be profitable in these circumstances without high milk prices. There may also be opportunities to invest in other methods of increasing on-farm water efficiency.

Testing whether such improvements in yield and water use efficiency are achievable under SSD warrants further research. The potential for improvement in the technical efficiency of other plant species using SSD irrigation, such as maize, also merits investigation. Installation of SSD technology is likely to be more attractive if the existing flood irrigation layout is very poor, or if SSD irrigation is installed on a 'greenfield' site, where new investment in irrigation development is essential.

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